Title: GEARBOX ADAPTOR

Technical Field

The present invention relates to a gearbox adaptor for insertion into a standard gearbox to convert a standard gearbox to a sequential gearbox. As used herein, the term 'standard gearbox' means a gearbox in which, to change from one gear to another, the gear-lever must be moved in a direction which depends upon which gear is being moved out of and which gear is being moved into. The term 'sequential gearbox' means a gearbox in which to change up a gear, the gear-lever always is moved in one direction, and to change down a gear, the gear-lever always is moved in the opposite direction.

Sequential gearboxes are especially useful in racing and rally cars, where rapid gear changes without looking at the gear-lever are essential.

Background Art

Purpose-built sequential gear boxes are known, but are much more expensive than standard gearboxes. Further, known sequential gearboxes provide a comparatively slow gear-change:- the engine must be unloaded to change gear, and the car therefore decelerates for the period of the gear change, (typically about 0.1 sec.), resulting in a loss of speed of the order of 3.5 kph.

It is therefore an object of the present invention to provide a gearbox adaptor which is capable of insertion into a standard gearbox to convert it to a sequential gearbox, the combination of providing a sequential gearbox in which gear changes can be made rapidly (typically 0.02 sec.) and at full throttle, so that the car does not lose speed during a gear change.

Disclosure of Invention

The present invention provides a gearbox adaptor including: a hub adapted to be engageable with a gear shaft for rotation therewith; at least one piston mounted within said hub; means for supplying fluid from the exterior of the hub to a first face of the or each said piston, so as to move said piston in a first direction; at least one clutch means adjacent the or each said piston, part of the or each said clutch means being engaged with said hub and a different part of the or each said clutch means being engageable with a gear locatable on said gear shaft adjacent said hub; the or

each said clutch means being located and arranged such that movement of said piston in said first direction inter-engages said parts of said clutch to drivingly engage said gear and said gear shaft.

Preferably, the piston and clutch means both are annular and are concentric with each other and with the hub. Preferably, the hub is concentrically engageable with the gear shaft.

Preferably the adaptor further comprises a casing surrounding at least part of the exterior of said hub, said casing being mounted upon said hub but not rotatable therewith; at least one first fluid passage being formed between the interior of the casing and the exterior of the hub, the or each said first fluid passage being in communication with said means for supplying fluid to a first face of the or each said piston, which comprises at least one second fluid passage formed through said hub.

It is known to provide a hydraulically operated piston, clutch, and hub system for a gearbox, but known systems supply hydraulic fluid through the gear shaft. This arrangement cannot be used to adapt existing gearboxes, since in existing standard gearboxes, the shafts are not provided with hydraulic passages.

The present invention further provides a sequential gearbox as defined above which includes a standard gearbox from which the synchro-hubs and cones have been removed and a gearbox adaptor in accordance with the present invention has been fitted to each gear. It is possible to use an adaptor of the present invention to adapt each gear individually, but preferably the double adaptor of the present invention is used, with each double adaptor being fitted between each pair of adjacent gears in the standard gearbox.

Preferably, all of the gears of a standard gearbox are adapted to the present system, but it is also possible to adapt only some of the gears of a standard gearbox, and leave the remaining gear or gears to be operated in known manner.

The sequential gearbox described above preferably includes electronic control means which comprises two micro switches which are connected via a sequencing arrangement to a set of solenoid valves, one solenoid valve being connected to the means for supplying fluid to each piston such that fluid is supplied to said piston when said solenoid valve is open and fluid is withdrawn from said piston when said solenoid valve is closed; the control means being such that each time the first micro switch is closed, the sequencing arrangement closes any solenoid valve which is

open and opens the next solenoid valve in a predetermined first sequence, and each time the second micro switch is closed, the sequencing arrangement closes any solenoid valve which is open and opens the next solenoid valve in a predetermined second sequence.

Preferably, the or each clutch means comprises a clutch pack which consists of a first series of spaced plates each of which is engageable with the hub for rotation therewith but which is reciprocable parallel to the longitudinal axis of said hub; and a second series of spaced plates each of which is engageable with a gear mounted upon said gear shaft but which is reciprocable parallel to the longitudinal axis of said hub; said second series of plates being interleaved with the plates of said first series.

Brief Description of Drawings

By way of example only, a preferred embodiment of the present invention is described in detail, with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic sectional view through part of a gearbox adaptor in accordance with the present invention, the adaptor being for a pair of gears;

Fig. 2a and 2b are plan views of two clutch components; and

Fig. 3 is a block diagram showing the electronic controls.

Best Mode of Carrying Out the Invention

Referring to Figs. 1 and 2 of the drawings, a gearbox adaptor 2 comprises a central splined shaft 3 upon which are mounted a hub 4, a first gear 5, a second gear 6, two pistons 7, 8 and two clutch packs 9, 10.

The shaft 3 is the main shaft of a standard gearbox and is externally splined, and driven in known manner. The hub 4 is internally splined and the hub splines engage the splines of the shaft 3 so that the hub 4 rotates with the shaft 3.

The first and second gears 5, 6 are gears of known type, forming part of a standard gearbox and are freely rotatable relative to the shaft 3, but are fixed in position relative to the length of the shaft 3.

The hub 4 has a central portion 4a concentric with the shaft 3, with a rim 11 around the periphery of said central portion. The rim 11 is of greater width than the central portion 4a.

The extension of the rim beyond the central portion of the hub provides two annular recesses in which the pistons 7, 8 and the clutch packs 9, 10 are mounted, concentric with the shaft 3.

Each piston 7, 8, is annular and is mounted adjacent one side of the central portion 4a of the hub, spaced from the hub by a passage 13, 14 respectively. The passages 13, 14 are connected to corresponding passages 15, 16 in the hub 4, through which hydraulic fluid can be supplied to the passages 13, 14, as hereinafter described.

Pairs of annular seals 17, 18, 19, 20 respectively, seal the gaps between the edges of the pistons 7, 8 and the adjacent walls of the gears and the hub respectively.

A further annular seal 21 (e.g. a cast-iron seal ring) extends around the outer wall of the rim between the passages 15 and 16. The seal 21 extends between the outer wall of the rim and a casing 22 which surrounds the hub 4 and is located on the hub by circlips 23. Bushes 24 may be located between the opposed faces of the hub 4 and casing 22, to permit the casing 22 to remain stationary while the hub 4 rotates. Alternatively, the bushes 24 may be omitted since the combination of the seal 21 and the layer of hydraulic fluid in the passages 15b, 16b between the outer wall of the rim and the inner wall of the casing 22 effectively acts as a bearing in practice.

Fluid passages 15a, 16a, corresponding to passages 15 and 16 are formed in the casing 22, for supply of hydraulic fluid.

Each clutch pack 9, 10 comprises a series of annular steel plates 25 interleaved alternately with a series of annular bronze plates 26. Each steel plate 25 is formed with four equidistantly-spaced dogs 27 (Fig. 2a only) which are dimensioned and arranged to engage corresponding grooves (not shown) in the adjacent face of the rim 11, so that the steel plates rotate with the hub but can move relative to the hub in the directions indicated by arrows A and B.

Alternatively, the steel plates 25 may be formed with external splines instead of the dogs 27, said splines engaging corresponding splines formed in the rim 11.

Each bronze plate 26 is formed with splines 28 around its inner periphery. The splines 28 are received in corresponding grooves (not shown) on the adjacent portions 30 of the gears 5, 6, so that the bronze plates 26 rotate with the gears 5, 6, but can move relative to the gears in the directions of arrows A and B.

It will be appreciated that the bronze plates 26 can be formed with dogs rather than splines. Further, the materials of which the clutch pack plates are made can be varied:- any suitable materials having acceptable wear characteristics and providing a good frictional grip, may be used (e.g. carbon fibre, sintered bronze).

To convert the whole of a standard gearbox using the present invention, all of the synchro-hubs and cones are removed from the standard box, and a gearbox adaptor as described above is fitted between each pair of gears: first/second and third/fourth. For reverse gear, the standard clutch system may be retained, or a single gear adaptor as hereinafter described, can be used. If the standard gearbox has an odd number of forward gears, then either the standard clutch system is used for the 'odd' gear or a single gear adaptor can be used.

To modify the above-described adaptor for a single gear, the hub shown in Fig. 1 is effectively split in two, by terminating the hub on a line X-X an Fig. 1, with a blank wall. This gives a single gear adaptor. It is possible to use a single-gear adaptor for each gear in a multi-gear box, but it is preferred to use two-gear adaptors as shown in Fig. 1, since this gives a more compact construction.

It also is possible to construct an adaptor as a single unit for three or more gears, by extending the design of Fig. 1. Further, although the invention is described as an adaptor for an existing gearbox, it will be appreciated that it is possible to build a gearbox 'from scratch' incorporating the adaptor of the present invention.

The above-described system can be controlled by any suitable control, but preferably is controlled by an electronic/hydraulic system as shown in Fig. 3.

The control system includes an electronic joystick (not shown) which is connected to a first and a second micro-switch 32, 33 such that when the joystick is moved in one direction, the first micro-switch 32 is closed, and when the joystick is moved in the opposite direction, the second micro-switch 33 is closed. The micro-switches 32, 33 are connected to a series of solenoid valves 50,60,70,80, each controlling the flow of hydraulic fluid to one section of one of the hubs 4, via a series of relays 51,61,71,81 and a sequencing arrangement (e.g. a control integrated circuit) which provide that each time the first micro-switch 32 is closed, the next solenoid in the sequence 50,60,70,80 is opened and each time the second micro-switch 33 is closed, the next solenoid in the sequence 80,70,60,50 is opened.

When the first solenoid valve is opened, hydraulic fluid is supplied through that valve to one of the passages 16a and hence to the associated passages 16 and 14, to push the piston 8 in the direction of arrow B. The piston 8 contacts the plates of the clutch pack 10 and pushes them in the same direction, urging the plates of the clutch pack into contact with each other and with the face 31 of the first gear. Since the plates 25 of the clutch pack are splined to the hub 4 and the plates 26 to the gear 5, and the hub 4 is splined to the shaft 3, pushing the plates 25, 26 together into driving contact with each other brings the first gear 5 into driving engagement with the shaft 3, and the gear rotates with the shaft, so that the vehicle drives in first gear. When the second solenoid valve is opened, the electronic control circuit closes the first solenoid. When the first solenoid valve is closed, the rotation of the gearbox tends to fling fluid out of the passages 14/16/16a, drawing the piston 8 back to the position of Fig. 1 and disengaging first gear.

When the second solenoid valve is opened, fluid is supplied to passages 15a/15 and 13 and the second gear is engaged in the same manner as the first.

Thus, every time the joystick is moved in said one direction, the solenoid valve (if any) which is open, is closed, and the next solenoid valve in the sequence 50,60,70,80 is opened, to engage the next higher gear. Every time the joystick is moved in the opposite direction, the solenoid valve which was open is closed, and next solenoid valve in the sequence 80,70,60,50 is opened to engage the next lower gear.

It is envisaged that the solenoid valves could be controlled automatically by a rev-counter, so that the gears are changed up or down automatically, depending upon the engine revs.